

1 Disengageable downhole tool

2

3 The present invention relates to downhole tools for use  
4 in the oil and gas industry and in particular although  
5 not exclusively to a disengageable downhole tool which  
6 allows a tool to be disengaged from a work string in a  
7 well bore and later retrieved on the work string when the  
8 work string is removed from the well bore.

9

10 In drilling or completing a well, each stage requires a  
11 work string to be made-up which includes any tools  
12 required within the well bore. Typically once made-up the  
13 work string is inserted in to the well until the tool  
14 reaches the desired location, the job is undertaken and  
15 then the work string including the tool is returned to  
16 the surface. As a number of jobs are required in a well  
17 in order to drill and complete the well, this can require  
18 a great number of trips into the well by a work string.  
19 Each time the string is retrieved, made up and reinserted  
20 time is lost which increases the cost involved in  
21 drilling and completing the well.

22

1 It has long been known to combine tools on a single work  
2 string. However, some tools such as the drill bit can  
3 only be located at a single position on the work string  
4 e.g. at the base.

5  
6 An example where a single tool is required to be placed  
7 on a work string is in the milling of a polished bore  
8 receptacle. A polished bore receptacle is typically  
9 positioned at the top of a production liner in  
10 conjunction with the liner hanger disposed in a well  
11 bore. The polished bore receptacle typically has a long  
12 polished bore, which slideably and sealingly receives a  
13 sealing assembly on the end of a tubing string. Due to  
14 its function of requiring a surface against which a seal  
15 can be made, the polished bore receptacle which is  
16 inserted into the well is generally milled and dressed to  
17 provide an ideal surface finish. Such milling and  
18 dressing of the receptacle and in particular the top  
19 portion of the liner requires a single trip into the well  
20 with a suitable milling assembly.

21  
22 Where multiple tools can be mounted on a single work  
23 string, difficulties can arise in the need to co-ordinate  
24 the activities of each of the tools independently from  
25 each other, particularly, if one tool is required to work  
26 before or after the operation of another tool.

27  
28 Further difficulty arises when a tool, in order to  
29 operate, must come into contact with a portion of the  
30 well bore lining or casing. In these circumstances, the  
31 tool must be capable of being retracted or moved away  
32 from the well bore lining or casing so that the work

1 string can be repositioned without the tool making  
2 unwanted contact to other parts of the well bore.

3  
4 An example of a retractable tool is that disclosed in  
5 Patent GB 2,346,629. This tool is mounted on a work  
6 string and operates by the application of fluid through  
7 the work string. Fluid pressure causes cleaning members  
8 in the form of brushes or scrapers to be expanded  
9 radially outwards to contact the walls of the well casing  
10 or liner. The work string can be rotated so that the  
11 brushes or scrapers clean the walls of the casing or  
12 liner. When cleaning is complete a change in fluid  
13 pressure causes the cleaning members to be retracted back  
14 into the work string so that the work string may be  
15 lowered further into the well or be retrieved from the  
16 well without the cleaning members making any further  
17 contact with the casing or liner. A disadvantage of such  
18 systems is that they require changes in fluid pressure  
19 from the surface and due to the mechanical components  
20 used to assist in the expansion and retraction of the  
21 cleaning members they can be prone to failure in hostile  
22 environments.

23  
24 It is an object of at least one embodiment of the present  
25 invention to provide a tool located on a work string,  
26 which when it has completed its function in a well bore  
27 can be disengaged from the work string such that the work  
28 string be run further into the well bore and when  
29 retrieved 'pick-up' the tool and remove it from the well  
30 bore.

31  
32 It is a further object of at least one embodiment of the  
33 present invention to provide a tool for insertion in a

1 work string including at least one further tool, which  
2 when the string is inserted into the well bore can mill a  
3 polished bore receptacle, remain at the polished bore  
4 receptacle while the one or more further tools perform  
5 their function(s) below the polished bore receptacle and  
6 is retrieved when the work string is retrieved from the  
7 well.

8  
9 It is a yet further object of at least one embodiment of  
10 the present invention to provide a tool for insertion in  
11 a work string which includes a safety feature such that a  
12 portion of the tool will disengage only when the tool has  
13 reached a desired location in the well bore.

14  
15 According to a first aspect of the present invention  
16 there is provided a downhole tool for location on a work  
17 string, the tool including an assembly operable in a well  
18 bore via the work string, wherein the assembly is  
19 disengagable from the work string at a selected location  
20 in the well bore, and wherein the tool further includes  
21 retrieval means to pick up the assembly on retrieval of  
22 the work string from the well bore.

23  
24 When disengaged the work string can move freely through  
25 the tool so that functions can be performed by other  
26 tools on the work string.

27  
28 Preferably the tool comprises a substantially tubular  
29 body upon which is located the assembly.

30  
31 Preferably the assembly is a sleeve positioned on an  
32 outer surface of the tool. More preferably the assembly  
33 is a milling sleeve. Advantageously, the assembly is a

1 milling sleeve suitable for milling a polished bore  
2 receptacle in a well bore. Preferably, also the sleeve  
3 includes one or more longitudinally arranged milling ribs  
4 to dress an internal diameter of the top of the polished  
5 bore receptacle. Further the sleeve may include an  
6 additional milling portion, scrapers or brushes on an  
7 outer surface. Advantageously, the sleeve has a length  
8 equal to the length of the polished bore receptacle.  
9

1 .0 Preferably, the assembly is operated from the work string  
1 .1 by a hex-drive system.  
1 .2

1 .3 Preferably the body has a portion of an outer surface  
1 .4 having a plurality of longitudinally extending planar  
1 .5 sections arranged around a circumference of the body.  
1 .6

1 .7 Preferably the assembly includes an inner surface, a  
1 .8 portion of which has a plurality of longitudinally  
1 .9 extending sections matching those of the body, such that  
2 20 when the body is rotated by virtue of the work string  
2 21 being rotated, the assembly is rotated also.  
2 22

2 23 Preferably the assembly includes a shoulder on the inner  
2 24 surface thereof, the shoulder providing a ledge upon  
2 25 which a portion of the body engages when the tool is  
2 26 retrieved from the well bore. Advantageously, a portion  
2 27 of the body is that portion provided as a ledge by the  
2 28 plurality of longitudinally extending planar sections.  
2 29

3 30 Preferably the assembly is detachably coupled to the  
3 31 body. More preferably, the detachable coupling is by one  
3 32 or more shear pins.  
3 33

1 Preferably the assembly has an outer shoulder, the outer  
2 shoulder contacting a formation in the well bore to cause  
3 the shear pins to shear and decouple the assembly from  
4 the body thereby disengaging the assembly from the work  
5 string.

6  
7 More preferably, the shear pins are arranged so that they  
8 take no stress on operation of the assembly from the work  
9 string. Advantageously the pins include a constricted  
0 portion positioned at a plane between the assembly and  
1 the body so that no stress is exacted on the pins when  
2 the body is rotated, rotating the assembly with it.

3  
4 Preferably also the body and the assembly include means  
5 for retaining sheared parts of the sheared pins to  
6 prevent them from dispersing into the well bore.

7  
8 Preferably the means for retaining sheared parts of the  
9 shear pins is by pockets located in the body and the  
0 assembly.

1  
2 Advantageously the tool includes a safety mechanism to  
3 prevent premature decoupling of the assembly prior to the  
4 assembly reaching a selected location in the well bore.

5  
6 Preferably a safety mechanism operates when the assembly  
7 reaches a selected formation at the selected location for  
8 the assembly to operate.

9  
0 Preferably the safety mechanism comprises a button  
1 mounted in a first position to lock the assembly to the  
2 tool body, the button having a face engageable with the  
3 selected formation, whereupon engagement with the

1 selected formation moves the button from the first  
2 position to a second position, disengaging the lock and  
3 wherein the selected formation maintains the button in  
4 the second position while the selected formation contacts  
5 the assembly thereby disengaging the assembly from the  
6 work string.

7  
8 According to a second aspect of the present invention  
9 there is provided a method of running a work string in a  
10 well bore to operate more than one tool on a single trip,  
11 the method comprising the steps:

- 12 a) locating a first tool, including an assembly, operable  
13 in a well bore on the work string, the work string  
14 including one or more further tools located below the  
15 assembly;
- 16 b) running the work string into the well bore until the  
17 assembly reaches a selected location and at this  
18 location operating the first tool via the work string;
- 19 c) disengaging the assembly from the work string at the  
20 selected location;
- 21 d) passing the work string beyond the assembly until the  
22 one or more further tools have reached desired  
23 locations and performed their functions;
- 24 e) removing the work string from the well bore; and
- 25 f) picking up the assembly on the work string as the work  
26 string is retrieved.

27  
28 Preferably, the assembly is a milling assembly for  
29 milling and dressing a polished bore receptacle in the  
30 well bore.

31

1 Preferably also the assembly is disengaged from the work  
2 string by contacting the assembly with a formation in the  
3 well bore and setting down weight on the work string.

4  
5 Preferably also the assembly is picked up by the work  
6 string by contacting a ledge on the work string with a  
7 shoulder on the assembly.

8  
9 According to a third aspect of the present invention,  
10 there is provided a method of milling a polished bore  
11 receptacle in a well bore on the same trip as other  
12 functions are performed in the well bore, the method  
13 comprising the steps:

- 14 a) mounting a milling assembly in the form of a sleeve  
15 including one or more milling elements onto a body  
16 in a work string;
- 17 b) connecting a drive between the assembly and the body  
18 and coupling the assembly to the body;
- 19 c) running the work string in the well bore until the  
20 milling assembly reaches the polished bore  
21 receptacle;
- 22 d) rotating the work string and thereby through the  
23 drive rotating the milling assembly to mill and  
24 dress the polished bore receptacle;
- 25 e) resting a portion of the assembly on the top of the  
26 polished bore receptacle and setting down weight on  
27 the work string to disengage the coupling between  
28 the assembly and the body;
- 29 f) running the work string further into the well bore  
30 and operating one or more further tools from the  
31 work string;
- 32 g) retrieving the work string from the well bore and  
33 engaging a portion of the body to a shoulder on the



1 assembly so that the assembly is picked up by the  
2 work string and retrieved from the well bore.

3  
4 Embodiments of the present invention will now be  
5 described by way of example only with reference to the  
6 following figures in which:

7  
8 Figure 1 shows a part cross-sectional view of a downhole  
9 tool in accordance with a first embodiment of the present  
10 invention;

11  
12 Figure 2 shows a cross-sectional along section line A-A  
13 of the tool of Figure 1;

14  
15 Figure 3 shows an enlarged portion of the downhole tool  
16 of Figure 1 illustrating the detachable coupling  
17 arrangement; and

18  
19 Figure 4 shows a portion of a downhole tool including a  
20 safety mechanism according to a third embodiment of the  
21 present invention.

22  
23 Reference is initially made to Figure 1 of the drawings  
24 which illustrates a downhole tool, indicated by reference  
25 numeral 10, in accordance with a first embodiment of the  
26 present invention. Tool 10 comprises an annular body 12  
27 having an axial bore 14 there through. At an upper end 16  
28 of the body 12 there is a box section 18 allowing  
29 connection of the body 12 onto a work string (not shown).  
30 At a lower end 20 of the body 12 is a pin section 22 to  
31 allow the body 12 to be threadably connected to the work  
32 string (not shown). Therefore the body 12 of tool 10 may  
33 be mounted within a work string. This work string may of

1 course have one or more tools located upon it and  
2 preferably a tool will be mounted on the work string  
3 below the lower end 20 of the tool 10.

4 Mounted on the body 12 is a sleeve 24 comprising two  
5 sections. The first is a longitudinal section 26 which  
6 mates to the body 12 and typically can be extended to  
7 ensure that the sleeves are the required length for the  
8 jobs. For example, if the job is to mill a polished  
9 bore receptacle (PBR) as shown in Figure 1, section 26  
10 will be of a length so that the lower milling section 28  
11 can reach to the base of the polished bore receptacle 30.  
12 The second is outer section 32 which provides the  
13 function of the tool. Section 32 in the first embodiment  
14 includes on its surface a plurality of milling ribs 34  
15 which when turned will mill and dress the top 36 and  
16 inside wall 38 of the PBR 30.

17

18 Body 12 and sleeve 24 are mated together via a plurality  
19 of shear pins 40 shown schematically on Figure 1 together  
20 with a drive system shown in detail on Figure 2. The  
21 drive section is generally referenced by numeral 42. In  
22 the embodiment shown here, there are six shear pins  
23 holding the body 12 to the sleeve 24. At the mating  
24 portion 44 the inner surface 46 of sleeve 24 is provided  
25 on a polygon cross-sectional area. In the embodiment  
26 shown there are six planar surfaces making up the inner  
27 surface 46. A corresponding outer surface 48 is machined  
28 on the circumference of the body 12 at mating portion 44.  
29 The drive arrangement 42 is thus a hex drive and ensures  
30 that when the body 12 is rotated on the work string  
31 sleeve 24 will also rotate when surfaces 46 and 48 are  
32 aligned. The body 12 and sleeve 24 are held together by  
33 the shear screws or shear pins 40.

1  
2 With the aid of Figure 3 the arrangement of each shear  
3 pin 40 can be seen clearly. Shear pin 40 comprises a  
4 screw thread section 50, a constrictive section 52 and a  
5 head 54. An aperture 56 in the sleeve 24 ensures that  
6 each pin 40 can be inserted and screwed to a matching  
7 screw thread in body 12. Pin 40 is inserted to a point  
8 such that the head 54 engages a lip 60 on the sleeve 24.  
9 At this point, the constricted section 52, is against the  
10 plane 62 formed between the surfaces 46, 48 of the body  
11 12 and sleeve 24 respectively. Constricted section 52  
12 ensures that when the body 12 is rotated the torque is  
13 applied to the surface 46 and not to the shear pins 40.  
14 When inserted a plug 64 is screwed into the sleeve 24  
15 behind the pin 40 to prevent the ingress of debris to the  
16 aperture 56 and to ensure that when pin 40 is sheared the  
17 head 54 and sheared portion of the constricted section 52  
18 are retained within aperture 56 and cannot exit into the  
19 well bore. Conversely the threaded portion 50, which is  
20 sheared, remains attached to the body 12 and is likewise  
21 prevented from dislodging and entering into the well  
22 bore.

23  
24 In use sleeve 24 is mounted onto body 12 aligning  
25 surfaces 46, 48. Shear pins 40 are inserted through  
26 apertures 56 and so that sleeve 24 is coupled to the body  
27 12. Tool 10 is then connected into a work string by  
28 virtue on sections 18, 22. The work string can then be  
29 inserted into the well in the standard manner.

30  
31 When the outer portion 32 of sleeve 24 reaches the top 36  
32 of the PBR 30, the PBR 30 is then milled and dressed  
33 using the milling ribs 34 together with the bore milling

1 section 28 on the sleeve 24. Sleeve 24 is operated  
2 purely through rotation of the work string which in turn  
3 rotates the body 12 via the hex drive 42. Sleeve 24 is  
4 turned and thus milling ribs 34 and milling section 28  
5 can mill and dress the inside walls 38 and the top 36 of  
6 the PBR 30.

7  
8 Once this function is complete the sleeve 24 is located  
9 against the PBR 30 at the top 36. The work string is then  
10 set down on a weight of approximately 10,000 lbs, top 36  
11 acting as a formation in the well bore and the tool then  
12 becomes a weight set tool. Setting weight on the tool  
13 causes the pins 40 to shear due to the planar arrangement  
14 of surfaces 46, 48. The body 12 together with the work  
15 string will disengage from the sleeve 24, sleeve 24 will  
16 remain at the liner top 36 while the body 12 and work  
17 string can descend further into the well bore. A tool  
18 connected to the work string (not shown) can then perform  
19 any required function at a greater depth in the well  
20 bore.

21  
22 When all functions are complete in the well bore the work  
23 string is removed in the standard manner. When the  
24 string brings the meeting portion 44 of the body 12 up to  
25 the meeting portion 44 of the sleeve 24 if the surfaces  
26 46, 48 do not align the sleeve 24 will be picked up by  
27 virtue of the top ledge formed from the surface 46  
28 meeting the bottom ledge formed from surface 48.

29  
30 Alternatively, if the surfaces 46, 48 match then the body  
31 mating portion 44 slides into the matching mating portion  
32 44 of the sleeve. The sleeve 24 is then picked up by the  
33 upper ledge formed from the planar sections of the

1 surface 48 now mating with a shoulder 64, see Figure 1,  
2 in the sleeve 24. The shoulder 64 is further illustrated  
3 in Figure 3. On picking up the sleeve 24, the sleeve 24  
4 moves with the body 12 and is removed from the well bore.

5  
6 Reference is now made to Figure 4 of the drawings which  
7 illustrates a safety mechanism mounted on the sleeve 24  
8 of the tool 10 according to a second embodiment of the  
9 present invention. The safety mechanism 66 is as  
10 disclosed in UK Patent Application No 0126550.3 to the  
11 Applicants and is incorporated herein by reference.

12  
13 Safety mechanism 66 comprises a cylindrical body or  
14 button 68. In one end 70 of the button 68 there is a  
15 contact face 72. Face 72 is planar and located at an  
16 acute angle to the button 68. At an opposing end 74 there  
17 is located a magnet 76. Located between opposing ends  
18 70,74 is a narrowed section 78 of the button 68. The  
19 narrowed section provides a weak point on the button 68  
20 making it susceptible to shearing across the narrow  
21 section 78. It will be appreciated that instead of a  
22 narrow section the button could include a section of  
23 differing material which is weaker than the remaining  
24 material and can be equally susceptible to shearing.

25  
26 In use, button 68 is inserted through a portion or recess  
27 80 of the sleeve 24 and the body 12. The button 68 is  
28 positioned such that the narrow section 78 is kept away  
29 from plane 62 between the body 12 and sleeve 24. This is  
30 achieved by the insertion of bissel pins (not shown).  
31 When the tool 10 is inserted into the well bore, the  
32 safety mechanism 66 remains in this position until the  
33 polished bore receptacle 30 contacts the face 72 of the

1 button 68. On contacting the face 72 the PBR 30 causes  
2 the button 68 to be pushed into the recess 80. Once  
3 pushed fully in the PBR 30 comes to rest on an upper face  
4 82 of the sleeve 24. In this position the PBR 30  
5 maintains the button 68 in a position where the narrow  
6 section 78 lies on the shear plane 62. The button 68 is  
7 held in this position by the inner surface 38 of the PBR  
8 30. This contact has caused the sleeve to remain  
9 stationary relative to the body 12. Weight applied to  
10 the body 12 now causes the shear pins 40 to shear along a  
11 narrow section 78 of the safety mechanism 66. Once  
12 sheared the sleeve 24 moves relative to the body 12 to  
13 allow the work string to become free of the sleeve 24  
14 disengaging the milling assembly. While the tool 10 is  
15 being set the button 68 is always held inwards where it  
16 may be sheared by the continued contact of the surface 38  
17 of the PBR 30 with the face 72 of the button 68. This  
18 dual function of the PBR 30 in both holding the button 68  
19 inwards while contacting the sleeve 24 to set the tool  
20 allows the tool only to be set by the PBR 30.

21

22 As setting of the tool occurs only when the PBR provides  
23 the dual role of holding the button inwards while  
24 contacting the sleeve, it is unlikely that any unintended  
25 formation in the well bore could achieve both these  
26 functions simultaneously and thus the tool will not  
27 operate until it reaches the PBR.

28

29 The principle advantage of the present invention is that  
30 it provides a downhole tool which can perform more than  
31 one function on a single trip into the well bore. In  
32 particular, the tool provides for the milling of a  
33 polished bore receptacle while allowing the work string

1 to travel further into the well and perform other  
2 functions.

3 A further advantage of the present invention is that it  
4 provides a tool, which retrieves all parts thereof on  
5 removal from the well.

6

7 A yet further advantage of the present invention is that  
8 it includes a safety mechanism to ensure that the  
9 assembly only disengages at a selected location in the  
10 well bore.

11

12 It will be appreciated by those skilled in the art that  
13 various modifications may be made to the invention  
14 disclosed herein without departing from the scope  
15 thereof. For instance, the description relates to a  
16 milling assembly being disengaged on the work string,  
17 however other tools can be disengaged such as sensors or  
18 cleaning equipment. Presently we have not disclosed  
19 other tools suitable for operation in the work string and  
20 it will be appreciated by those skilled in the art that  
21 any tool may be placed below the assembly to operate on  
22 the work string. In fact, it would be possible to  
23 include one or more of these assemblies on a single work  
24 string, each disengaging at a selected location, as the  
25 casing or liner diameter decreases with the depth of the  
26 well bore. Further, it will be appreciated that although  
27 a hex drive mechanism is shown to drive the assembly from  
28 the work string, any drive mechanism which can disengage  
29 and decouple allowing free passage of a work string  
30 through the assembly would be suitable. Additionally, in  
31 this respect the number of shear pins required to hold  
32 the assembly to the work string on its descent into the  
33 well may be varied.